

Sub B1
A₁ 1. (amended) An etchant solution which [is selective of borophosphosilicate glass to tetraethyl orthosilicate] selectively etches borophosphosilicate glass over tetraethyl orthosilicate, said etchant solution comprising an organic acid and a fluoride-containing solution.

Sub B2
A₂ 4. (amended) The etchant of claim 1, wherein said organic acid comprises [99.7%] glacial acetic acid [by weight in water] and said fluoride-containing solution comprises 49% hydrofluoric acid by weight in water.

Sub B3
A₃ 7. (amended) The etchant of claim 1, wherein said organic acid comprises [99.7%] glacial acetic acid [by weight in water] and said fluoride-containing solution comprises 40% ammonium fluoride [acid] by weight in water.

REMARKS

The Office Action mailed October 28, 1999, has been received and reviewed. Claims 1-8 are currently pending in the application. Claims 1-8 stand rejected. Applicant has amended claims 1, 4, and 7 and respectfully requests reconsideration of the application as amended herein.

35 U.S.C. § 112 Rejection

Claim 1 stands rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicant regards as the invention. The Examiner states that it is "unclear whether or not TEOS is etched by the solution." Paper 3, page 2. Claim 1 has been amended to clarify that the etchant solution selectively etches borophosphosilicate glass ("BPSG") over tetraethyl orthosilicate ("TEOS"), as supported by the specification at page 3, lines 18-22. The etchant solution is 27 to 55 times more selective for BPSG than for TEOS. Page 4, table 1. In other words, as understood by those of ordinary skill in the art, the etchant solution etches BPSG at a much higher rate than TEOS.

35 U.S.C. § 102(b) Rejections

Claims 1-3 stand rejected under 35 U.S.C. § 102(b) as being anticipated by United States Patent No. 5,395,482 to Onda et al. ("Onda"). A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference. *Verdegaal Brothers v. Union Oil Co. of California*, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). The identical invention must be shown in as complete detail as is contained in the claim. *Richardson v. Suzuki Motor Co.*, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989). Applicant respectfully submits that Onda does not disclose every element of claim 1.

The Examiner states that Onda discloses an etchant solution "which is selective to BPSG and TEOS." Paper 3, page 3. However, upon close examination of Onda, Applicant believes that Onda does not disclose a selective etchant solution. Instead, Onda discloses a vapor phase treatment method to extract impurities from the surface of a semiconductor wafer. Column 1, lines 6-12. The Onda method uses vaporous hydrofluoric acid to remove impurities from the surface of a semiconductor wafer. Onda further discloses that this method is not limited to use on a semiconductor wafer but can also be applied to a "BPSG film by a CVD method" and an "oxide film by a TEOS method." Column 22, lines 61-66. While Onda discloses that this method may be used with BPSG and TEOS, it does not mention any selectivity for BPSG over TEOS. Rather, Onda merely discloses that BPSG films and oxide films by a TEOS method can be used as objects to be treated by his method.

In contrast, the present invention discloses a solution for use in a wet etching process whereby a semiconductor device, which contains BPSG *and* TEOS, can be selectively etched by an etchant solution that is composed of an organic acid and a fluoride-containing compound. An exemplary application of this invention includes a TEOS layer deposited over the semiconductor device components, followed by a BPSG layer deposited over the TEOS layer. Page 3, lines 18-20. The TEOS layer is used to prevent boron and phosphorus in the BPSG layer from contaminating the components of the semiconductor device. Page 3, lines 15-17. The etchant solution is used to etch desired areas in the uppermost BPSG layer. Since the etchant solution is between 27-55 times more selective for BPSG than for TEOS, the solution will etch the BPSG

layer but will substantially cease etching when the TEOS layer is exposed. Page 3, lines 20-22; Page 4, Table 1.

Since Onda does not disclose an etchant solution of the claimed constituency that selectively etches BPSG over TEOS, Onda does not disclose every element of claim 1. Therefore, Applicant respectfully requests that the anticipation rejection of claim 1 be withdrawn. In addition, the rejections to dependent claims 2 and 3 should be withdrawn because these claims depend on claim 1, which is allowable as amended.

35 U.S.C. § 103(a) Obviousness Rejections

Claims 4-8 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Onda et al. ("Onda"), United States Patent No. 5,395,482. M.P.E.P. § 706.02(j) provides the appropriate standard for obviousness:

To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicants' disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

Applicant notes that the Patent Office bears the burden of establishing a *prima facie* case of obviousness. *In re Linter*, 458 F.2d 1013, 173 U.S.P.Q. (BNA) 560 (CCPA 1972). Applicant respectfully submits that claims 4-8 are not obvious for three reasons. First, there is no motivation or suggestion to modify Onda to render the claimed invention obvious. Second, Onda teaches away from the claimed invention. Third, a dependent claim is allowable if the claim on which it depends is allowable.

Addressing the first issue, the Examiner states that "it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Onda by varying the volumetric ratios of the solution components, because routine experimentation is obvious for the

purpose of determining the best mode." Paper 3, page 3. However, M.P.E.P. § 2143.01 states that "[i]f [the] proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification." Applicant submits that the proposed modification to the vapor process of Onda would render Onda unsatisfactory for its intended purpose.

As discussed above, Onda discloses a *vapor* phase treatment method to extract impurities from the surface of a semiconductor wafer. Column 1, lines 6-12. The method uses vaporous hydrofluoric acid to remove impurities from the surface of a semiconductor wafer. The disclosed Onda apparatus delivers a vaporized reagent, such as hydrofluoric acid, to the surface of a semiconductor wafer. The vapors form small droplets when they contact the cooled surface of the wafer. These droplets dissolve impurities in the exposed wafer layer, which are then removed by a micro pipette.

The proposed modification of replacing the vapor etch process in Onda with a solution-based wet etch process is used with the claimed invention would render the Onda method and apparatus unsatisfactory for its intended purpose for two reasons. First, if the etchant solution was applied to the wafer as a liquid, instead of as a vapor, the necessary small droplets would not form to dissolve the impurities in the exposed wafer layer. Instead, the wafer would be covered by a layer of liquid reagent and the impurities in the semiconductor device would not be dissolved in discrete droplets that could be easily removed by micro pipette. Second, Onda discloses that high purity reagents are necessary to remove the trace levels of impurities from the exposed wafer layer. Vaporizing the liquid reagent generates mists, which encircle the impurities in the reagent. The reagent impurities are trapped by a hydrophobic porous film before they reach the surface of the exposed wafer layer, resulting in high purity reagents. Column 10, lines 26-32. If a wet etch process using the solution of the claimed invention were used, no mists would be formed to encircle the reagent impurities and the impurities would not be subsequently removed by the hydrophobic film. Column 10, lines 20-32; Column 5, lines 23-27. Since Onda discloses that the impurities in the exposed wafer layer are present in trace amounts, high purity reagents are needed to remove the impurities.

In summary, replacing the vapor etch process of Onda with a wet etch process using the solution of the claimed invention would not result in the necessary droplets to dissolve the wafer impurities, thus rendering the Onda invention unsatisfactory for its intended purpose. In addition, using a wet etch process would result in impure reagents being used to dissolve the trace impurities in the exposed wafer layer. This would also render the Onda invention unsatisfactory because the necessary level of sensitivity could not be reached. Therefore, since the proposed modifications would render the Onda invention unsatisfactory for its intended purpose, there is no suggestion or motivation in Onda to render the claimed invention obvious and the rejections to claims 4-8 should be withdrawn. Further, one would have to modify Onda through the use of an undisclosed solution in addition to modifying his process.

In addition, there is no teaching or suggestion whatsoever in the reference relating to concentrations of individual constituents or ratios of constituents which would lead one of ordinary skill in the art to formulate the claimed etchant solution including limitations recited in any of claims 4-8, inclusive. It appears to Applicants that the only teachings of such limitations appears in Applicants' own disclosure, the use of which by the Examiner would constitute impermissible hindsight. This is particularly true since Onda dwells on the use of vapors and mixtures of vapors, which mixtures would be extremely difficult to control to arrive at different ratios of constituents. Thus, all of the claim limitations of claims 4-8 remain untaught by Onda.

Second, M.P.E.P. § 2144.05 states that a "*prima facie* case of obviousness may . . . be rebutted by showing that the art . . . teaches away from the claimed invention." Onda discloses that "[i]t is desired that reagent vapors vaporized from the liquid reagent are not liquidized until they contact the specimen." Column 14, lines 7-9. If the solution of the claimed invention were used, the reagent would be in a liquid phase for the whole process, not just at the time the reagent contacted the semiconductor wafer. Since Onda specifically discloses that vaporous reagents are necessary, Onda teaches away from using liquid reagents. Therefore, the wet etch process of the claimed invention is not obvious and the rejections to claims 4-8 should be withdrawn.

Finally, the rejections to claims 4-8 should be withdrawn because these claims are directly or indirectly dependent on claim 1, which is allowable as amended. The rejections

should be withdrawn because a dependent claim is obvious only if the independent claim from which it depends is obvious. See *In re Fine*, 5 U.S.P.Q.2d 1596, 1600 (Fed. Cir. 1988); See also M.P.E.P. § 2143.03.

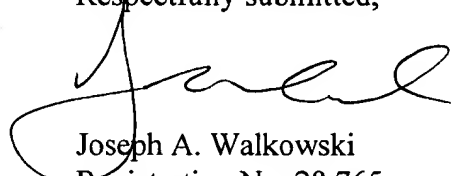
Entry of Amendments

The amendments to claims 1, 4, and 7 above should be entered by the Examiner because the amendments are supported by the as-filed specification and drawings and do not add any new matter to the application.

CONCLUSION

Claims 1-8 are believed to be in condition for allowance, and an early notice thereof is respectfully solicited. Should the Examiner determine that additional issues remain which might be resolved by a telephone conference, she is respectfully invited to contact Applicant's undersigned attorney.

Respectfully submitted,



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